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EXPLANATION OF PLATE VIII.

- FIG. 1.—*Diaptomus sanguineus*, ♀, × 42.
 “ 2.—Dorsal outline of the same.
 “ 3.—*Diaptomus sanguineus*, ♂, geniculate antenna, × 50.
 “ 4.— “ “ ♂, right leg of fifth pair, × 67.
 “ 5.— “ “ ♂, left “ “ × 70.
 “ 6.— “ “ ♀, leg of fifth pair.
 “ 7.— “ “ second maxilliped, × 63.
 “ 8.— “ *stagnalis*, antennula, × 48.
 “ 9.— “ *sicilis*, ♂ fifth pair of legs, × 160.
 “ 10.— “ *stagnalis*, ♂, fifth pair of legs, × 48.
 “ 11.— “ “ ♂, geniculate antenna, × 22.
 “ 12.— “ “ ♂, left antenna, × 22.
 “ 13.— “ *sanguineus*, mandible, × 160.
 “ 14.— “ *stagnalis*, ♀, leg of fifth pair, × 86.
 “ 15.—*Epischura lacustris*, ♀, fifth pair of legs, × 88.
 “ 16.— “ “ ♀, side view of abdomen, × 17.
 “ 17.—*Diaptomus leptopus*, ♀, leg of fifth pair, × 66.
 “ 18.— “ “ ♂, right leg of fifth pair, × 66.
 “ 19.— “ “ ♂, left “ “ × 66.
 “ 20.— “ *sicilis*, ♀, fifth pair of legs, × 160.
 “ 21.—*Epischura lacustris*, mandible and palpus.
 “ 22.— “ “ blade of mandible.
 “ 23.— “ “ ♀, abdomen and furca from above, × 48.
 “ 24.—*Osphranticum labronectum*, first maxilliped, × 180.
 “ 25.—*Epischura lacustris*, ♂, fifth pair of legs, 70.
 “ 26.— “ “ second maxilliped, × 88.
 “ 27.— “ “ leg of first pair, × 70.
 “ 28.—*Osphranticum labronectum*, ♀, leg of fifth pair, × 70.
 “ 29.— “ “ ♂, fifth pair of legs, × 70.

(To be continued.)

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THE LOESS OF NORTH AMERICA.

BY R. ELLSWORTH CALL.

(Continued from May number.)

Physical Geography of the Loess Era.—The Champlain epoch, to which the loess belongs, was characterized by general continental depression, which lessened the area of the land and increased the average temperature. Such a depression was followed by extensive encroachment of the sea and its arms upon the land, the effects of which would be greatest in the great central basin of the continent. Hence there was a backing up of all the streams and a general sluggishness or complete loss of their currents in the lower portions of their valleys. At their sources extensive denudation was in progress, and the material thus derived

was borne downward to the still portions below, and here the burden of the waters was cast as a blanket over their bottoms. The continued recession of the glaciers by dissolution kept the supply of water constant, or often swelled it to floods, thus permitting extensive denudations over large areas. "Below the falls of the Missouri the channel makes its way through the soft yielding clays and sands of the Cretaceous beds for about 250 miles" (Hayden). These beds extend nearly to the mouth of the Milk river, and then begin the Tertiary lignite formations, which are also here composed of sands, marls and clays. For another 250 miles the Missouri flows through rocks of this age, and then the Cretaceous slates again appear, which, according to Hayden, extend nearly to Council Bluffs, a distance of over 500 miles in a straight line. Now the amount of denudation possible to be accomplished by so large a stream, and in some of the most rapid portions of its ancient and present course, cannot be estimated, and especially is it needless to hazard any conjecture when we consider the character of the formations it traversed for a distance much exceeding 1000 miles! It is entirely adequate to form deposits many times greater than the whole extent of the loess in America. Into the ancient Lake Missouri, then, was poured the drainage of a vast area, and over a tenth of Iowa and a fourth of Nebraska the sediment it contained was deposited.

To another cause than the depression of the continent¹ must the great extent of the Missouri valley loess be attributed, and that cause was the narrowing of the valley south of St Joseph, acting as a barrier to the waters which then were spread out into lake-like proportions. With the gradual disintegration of its barrier and the recession of the sea consequent on the reëlevation of the land, the lake was gradually drained, leaving its former silt-covered bed as the surface soil—a waste of mud and lakelets in place of the former broad expanse of water. The changes in level and aspect keep pace each with the other. Soon the desert waste abounds with a rich vegetation, the soil is clothed with grass and flowers, and the forests begin anew to grow. But the rivers were not idle. A period of erosion began—not yet ended—by means of which the great streams plowed them channels to

¹ The estimates of the totality of this depression vary from 200 to 500 feet, any of which would be sufficient to extend the gulf line northward as far, at least, as the mouth of the Ohio.

the sea through sediment of their own deposition. Ten thousand rills and rivulets from the adjacent hills, aided by wind, by storm, by rain, by frost, began the sculpturing of the landscape anew until the beauteous arrangement of hill and dale appears, and which gives the loess regions their peculiar topographical features.

Bibliography.—The literature of the loess is scattered through many volumes, a great majority of which are not easy of access to the general reader. The following list will be found to be nearly or quite as perfect, at least, as opportunity has permitted. It is believed to embrace nearly all yet written on this subject :

AUGHEY, SAMUEL.—*The Superficial Deposits of Nebraska*. Ann. Rept. U. S. Geol. and Geog. Surv. of Colorado and adjacent territory (1874). pp. 243–269.

Contains a general account of the surface geology of Nebraska. Those portions relating to the loess (pp. 245–255) contains the following sub-sections : “The Loess Deposits,” recording certain geographical, physical and chemical facts, the last illustrated by five tables of analyses of loess soil. “Cause of these Peculiarities,” treating especially of the action of carbonic acid and water. The next section treats of “Fruit on the Loess Deposits,” and is followed by one on the “Scenery of the Loess Deposits.” Then follows a discussion of the “Origin of the Loess Deposits,” in which the aqueous theory is advocated with numerous confirmatory facts. This section is followed by one on the “Length of the Loess Age,” and one on its life. The article closes, pp. 266–269, with a provisional list of the mollusks of the lacustrine deposits, in which mention is made of 124 forms. Attention has been elsewhere¹ called to this list which appears in the “Sketches” mentioned below without modification.

AUGHEY, SAMUEL, Ph.D.—*Sketches of the Physical Geography and Geology of Nebraska* (1880). 8vo, pp. 326.

Contains a complete and valuable account of the loess of Nebraska. Discusses the theories relating to its origin, the argument being mainly directed against the views of Von Richthofen. Gives list of life remains, and mentions the finding of human relics. Concludes that the Nebraska loess is of lacustrine origin. An expansion of the previous article.

BLAKE, W. P.—*Geology of the 35th Parallel*, in Vol. III Pacific R. R. Reports. Pt. IV, pp. 11 and 22 (1856).

Notices of the loess in the valley of the Mississippi, and along both sides of the Arkansas as far as Little Rock. Names certain fossils which are, however, European. Notices also a similar deposit on the Red river above Ft. Washita. At this latter point is noted the occurrence of *Lymnæa*, *Physa*, *Planorbis*, *Pupa* and *Helix*. The same author, in Vol. II of the same series, repeats substantially the same matter.

BROADHEAD, G. C.—*Origin of the Loess*. Am. Journal of Sci. and Arts, Vol. XVII (1879), pp. 427–428.

Concludes Von Richthofen's hypothesis inapplicable to the loess of the Mississippi

¹AM. NAT., Vol. xv, p. 585.

and Missouri rivers. Mentions localities of evident *stratification*. Material supposed to be derived mainly from the Tertiary and Cretaceous rocks of the Upper Missouri. Considers the deposit lacustrine.

CALL, R. ELLSWORTH.—*Geology and Natural History of Fremont Co., Iowa* (1880). pp. 35. (Extracted from history of Fremont Co., Iowa.)

Mentions distribution and physical features of the loess in this portion of Iowa, and the physical geography of the loess era. The article partakes entirely of the character of a popular treatment of the surface geology of the county.

CALL, R. ELLSWORTH.—*Fossils of the Iowa Loess*. Am. Nat., Vol. xv, pp. 585-586 (1881).

Notifies the distribution of the loess in Southwestern Iowa. Calls attention to the number of species of fossils as mentioned by various observers. Lists of fossil land and fresh-water shells found in the counties of Mills and Fremont.

CALL, R. ELLSWORTH.—*The Loess in Central Iowa*. Am. Nat., Vol. xv, pp. 782-784 (1881).

Records the discovery of loess in Central Iowa, over large areas adjacent to the Des Moines river. A section accompanies, exhibiting the relation of the loess at Des Moines to other geological horizons. Lists fossils found.

DANA, JAMES D.—*Manual of Geology*. 2d edition, pp. 547-548 (1876).

General description of the alluvial deposits of the Champlain period. Notes only the loess of the Southern States, quoting Hilgard and Safford. Lists a number of fresh-water fossil shells from the loess of the Mississippi, but no mention is made of land forms, which alone are listed by both Hilgard and Wailes.

D[ANA] J. D.—Review of "*The Loess of the Rhine and Danube*," by Thomas Belt, F.G.S. Am. Jour. of Sci. and Arts, Vol. XIII, pp. 383-384 (1877).

A brief review of the principal conclusions reached by Mr. Belt with reference to the Rhine and Danube deposits, in the light of the geology of Eastern North America. Controverses the conclusion that various sub-glacial streams were dammed by ice to produce the terraces along the valley of the Rhine, in Europe, and that of the St. Lawrence, in Canada. Contains little on the general subject of this paper.

D[ANA] J. D.—Review of "*China, by Ferdinand Freiherrn von Richthofen*." Am. Jour. of Sci. and Arts, Vol. XIV, pp. 487-491 (1877).

Contains an elaborate review of the first volume of this great work, the review being largely devoted to a statement of Von Richthofen's subaërial hypothesis of the origin of the loess. Gives all the salient features of the theory, together with the principal arguments relied upon as proof. Quotes the author's objections to Kingsmill's theory of marine submergence, as well as those advanced to Pumpelly's former view of fresh-water origin. The reviewer presents no theory of his own.

HAYDEN, DR. F. V.—*First Annual Report of the U. S. Geol. Survey of the Territories*, pp. 10, 12, 18-19, 45 (1867).

Contains a brief historical and geographical account of the loess in Nebraska. Notices of distinct stratification in certain localities. Remarks on the adaptability of the loess for vine culture.

HAYDEN, DR. F. V.—*U. S. Geol. Surv. of Wyoming and Contiguous Territory*, pp. 98-99 (1870).

Notifies the terraces at the city of Omaha, and indicates the probable physical

geography of the region at the time of their formation. Considers the loess to be an estuary or lacustrine deposit. The occurrence of Molluscan and Mammalian forms is noted. Herein (p. 99) occurs the first mention of *Unio* in the loess, "in the banks of some of the little streams."

HAYDEN, DR. F. V.—*Final Report on Nebraska*. H. R. Ex. Doc. No. 19. Part I. Geology, pp. 3-79 (1871).

Brief remarks on the loess in various parts of the report. Sometimes called yellow marl or bluff deposit. Great fertility and productiveness of the soil of Nebraska attributed to this deposit.

HILGARD, E. W.—*Agriculture and Geology of Mississippi*, pp. 194-197, and many references in agricultural report (1860).

Professor Hilgard herein gives a complete physical and chemical description of the loess. Its range in the State is minutely described, and its fossils are indicated, which, as he remarks, are exclusively terrestrial forms. This list is taken from Wailes' Report, with the addition of two forms. The mammalian remains stand as reported on by Professor Wailes six years previously. The author records the observation of "definite marks of stratification."

HILGARD, E. W.—*The Loess of the Mississippi Valley and the Æolian Hypothesis*. Am. Jour. of Sci. and Arts, Vol. XVIII, pp. 106-112 (1879).

This paper is the most elaborate review of Richthofen's hypothesis which has come under notice. The author states that it was not his "intention, at this time, to discuss exhaustively the question of the origin of the loess in general, but rather to formulate some of the more prominent objections lying against the application of the æolian hypothesis to some of the loess regions with which a long study has made me familiar." The author then proceeds to state Richthofen's objections, and to array certain facts in refutation. Certain structural peculiarities illustrative of aqueous action are adduced; and these are in turn succeeded by full notes of chemical peculiarities. Summing up the evidence the author concludes, "the sum total of anomalous conditions required to sustain the æolian hypothesis, partakes strongly of the marvelous."

H. H. HOWORTH.—*Traces of a Great Glacial Flood*. Geological Magazine, Jan., Feb., 1882.

MCGEE, W. J.—*Superficial Deposits in Northeastern Iowa*. Proc. Am. Asso. for the Adv. of Sci., Vol. XXVII, 1878.

This author frequently mentions a "loess-like clay" of very variable thickness in this portion of Iowa. Reference is made to its physical characters which seem to be precisely similar to those of true loess. Its marked peculiarities as a topographical feature is noted, and likewise the fact of its occurrence on hills relatively higher than those surrounding. Its relation to the subjacent drift proper is quite marked, but it often grades insensibly into the drift; its origin is referred to glacial action.

MCGEE, W. J.—*The Surface Geology of a part of the Mississippi Valley*. In the Geological Magazine, August, 1879. pp. 354-356.

Herein are given more fully the loess features of Northeastern Iowa, than in the article last cited. The formation is here characterized as "a whitish-yellow, loess-like clay, unstratified, free from gravel, sand and boulders." The author notes absence of stratification "except where it has been rearranged by fluvial agencies." Numerous peculiar and anomalous features of distribution are noted; it was found

sometimes to cover the summits of kames. It formed the upper surface of hills and ridges rising forty or fifty or even more feet above the general level, over which the same materials were never deposited.

NEWBERRY, J. S.—*On the Surface Geology of the Great Lakes and the Valley of the Mississippi*. Annals of the Lyceum of Nat. Hist. of New York, Vol. IX, pp. 213-234 (1869); also in Am. Nat., Vol. IV, p. 193 (1871).

This paper is a general discussion of the surface geology of the central portions of the United States, "bounded on the north by the Eozoic highland of Canada, on the east by the Adirondacks and Alleghanies, and on the west by the Rocky mountains." The portion—a small one—relating to the loess is to be found near the close of the article. The author describes it as "a lacustrine, non-glacial, drift deposit." Its distribution is noticed, and the manner of its deposition.

OWEN, DAVID DALE.—*Report of a Geological Survey of Wisconsin, Iowa and Minnesota, and incidentally of a portion of Nebraska Territory* (1852).

Pages 132-133 and 135-136 of this valuable report contain some of the earliest published data with reference to the loess deposits of Iowa and Missouri. The remarkable contour of the hills bordering the valley of the Missouri is noted; and, though the occurrence of both land and fresh-water shells is mentioned, only land and semi-aquatic forms are indicated, as follows: *Helix thyroides*, *H. alternata*, *H. monodon*, *Helicina occularia* (quere *occulta*), *Succinea campestris*? and *Pupa armifera*. The generally accepted theory of lacustrine origin is alluded to, and an illustration of "hills of silicious marl, below Council Bluffs" is given. On p. 135 the same formation as it occurs at St. Joseph, in Missouri, is noted, and the same fossils are quoted with the addition of *Helix fraterna*. Dr. Owen considered these deposits and those of the Wabash equivalent.

OWEN, DAVID DALE.—*Geological Survey of Kentucky*, pp. 17-22, 27-29 (1856).

The author mentions "frequently recurring beds" of "very fine silico-calcareous earth of pale reddish-gray or ashen flesh tint." He states that the calcareous matter is derived in great measure from the land and fresh-water shells disseminated through the formation. The following genera are indicated: *Helix*, *Helicina*, *Cyclostoma*, *Succinea*, *Pupa*, *Cyclas*, *Planorbis* and *Lymnæa*. In accounting for the calcareous concretions, found in considerable abundance, Owen says they are "formed by the percolation of water charged with carbonic acid, which, dissolving the calcareous matter in the upper part of the deposit, carries it by filtration to the lower part of the bed, re-depositing it in the form of hard masses." He gives a description of the physical geography at the period when these beds were formed.

PUMPELLY, R.—*The Relation of Secular Rock-disintegration to Loess, Glacial Drift and Rock Basins*. Am. Jour. of Sci. and Arts, Vol. XVII, pp. 133-144 (1879).

This paper was originally read before the National Academy of Sciences, April 10, 1878. It opens with a general notice of the features of the loess, and makes especial reference to its lithological character. In this paper he abandons the view formerly presented in his "Geological Researches in Mongolia," &c., and says the formerly received theories "required inconceivable conditions and are full of contradictions!" Accepts fully Von Richthofen's hypothesis of subaërial origin. The paper is a very suggestive one, but however applicable to China fails in America.

SAFFORD, JAMES M.—*Geology of Tennessee*, pp. 114 and 433-434 (1869).

Gives a general account of the loess of West Tennessee. Remarks that it is dis-

tinctly stratified. Gives a list of six species of land and four species of fresh-water shells, found fossil in the loess of that State.

SMITH, DR. E. A.—*Outline of the Geology of Alabama*. (From Berney's Handbook of Alabama.) No date. pp. 67-68.

A brief mention only of the loess and the theory of Von Richthofen. Urges as an objection to its subaërial deposition the existence only, in Alabama, of the loess on the "immediate banks of streams." Mentions Tuomey's identification of the loess on the Lower Tombigbee and Alabama.

SWALLOW, G. C.—*Second Annual Report of the Geological Survey of Missouri*, pp. 69-76 (1855).

This report contains one of the earliest and best descriptions of the loess of Missouri. Swallow gave it the name of "Bluff Formation" (p. 74), which term he employs throughout the volume. The origin is considered as lacustrine. In an appendix, p. 215, is given a catalogue of fossils, all determined by that eminent palæontologist, the late F. B. Meek. Chemical analyses are given, which have been elsewhere alluded to.

TODD, J. E.—*Richthofen's Theory of the Loess, in the light of the Deposits of the Missouri*. Proc. A. A. A. S., Vol. XXVII (1879). Read Aug., 1878. Also author's edition, pp. 10.

A very full and valuable criticism of the subaërial hypothesis. Considers separately the four principal points made by Richthofen. Contains valuable lists of fossils, and some novel observations on the depth to which roots penetrate the soil of the loess. This portion of the *brochure* is very valuable. The author concludes: "Even now we probably express the opinion of many students of the loess when we say that the subaërial theory has received attention and consideration, mainly because of the boldness and novelty of its conception, and the high rank and well-deserved reputation of its author, rather than on account of its real merits."

WAILES, B. L. C.—*Agriculture and Geology of Mississippi*. First Report, pp. 213-214 (1854).

Gives geographical distribution of the loess in Mississippi. Statement made that below the highlands of Arkansas, the formation is not met with on the western side of the Mississippi river. States that the fossils found are all terrestrial, and lists nine forms. (This is the list quoted by Hilgard.) *Mastodon* remains also noted.

WHITE, DR. C. A.—*Geology of Iowa*. Vol. I (1870), pp. 103-117, and numerous references in the sections devoted to county and regional geology.

The boundaries of the Missouri river loess are described, together with its general and chemical characters. The physical properties of the loess herein receive the most complete treatment yet accorded them. Dr. White concludes that "the deposit was formed as sediment in a fresh-water lake." Believes the material of the loess to have been derived from the Cretaceous and Tertiary strata of the Upper Missouri—"the most friable formations on the continent." In the Chemical Report, by Rush Emery, occur analyses of soil—those used in table preceding.

WITTER, F. M.—*History of Muscatine County, Iowa*. (The chapter, only, on Geographic and Geologic Features.) pp. 330-332. (187-).

This is extracted from a work of the above title, the date of the publication of which does not accompany the *brochure*. It contains a general account of the loess of

Southeastern Iowa, its distribution, aspects, fossils and deposition. The author accepts the theory of lacustrine origin.

WITTER, F. M.—*Notes on the Loess*. From the Muscatine Tribune (1879).

This is the title of a paper read before the Muscatine Academy of Science, February 10, 1879. It contains a general discussion of the Iowa loess, with incidental references to the same deposit in Nebraska and Missouri. Lists fossils from various localities in Iowa. "Entire absence of the families of Unionidæ and Viviparidæ in the loess" of various parts of the State is noted and commented on. Concludes in favor of the aqueous origin.¹

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ORGANIC PHYSICS.

BY CHARLES MORRIS.

(Continued from June number.)

IN the life history of the Metazoa, or many-celled animals, the products of cell division enter into a new relation. Instead of the new cells existing as separate, they exist as united individuals. But there is nothing to show that they otherwise differ in any essential respect from the results of Protozoan division. The germ still separates into its constituents, which become more and more polarly diverse, until a vast mass of new cells is produced, in which those with male excess of vigor are just equal to those with female excess.

But in this development of a matured body from its germ, several interesting features appear, which we must successively consider. The first of these is the separation of the body into two bilaterally similar halves, a result which, although partly or completely masked in the lowest classes of the Metazoa, is very distinctly declared in the higher classes. Under our hypothesis this separation of the body into two similar halves has a special significance. The two halves of the body are polarly distinct, being respectively male and female in chemical constitution, so that the body of the offspring represents that of both its parents.

This conclusion seems to necessarily arise. If the simplest animal cell be a polar organization, with acid and basic, or male and female poles, then its division is a sexual separation. If the two new cells continued to cohere, they would form a bilaterally

¹ In connection with these references information of much value and direct bearing may be found in an article by Professor J. D. Whitney on "The Chinese Loess Puzzle" in AM. NAT., Vol. XI, pp. 705-713, in which the author inclines to the sub-aërial hypothesis. See also the reports of the geological surveys of Illinois, Ohio, Indiana and Michigan.